

concentration which is sufficiently low as to prevent the substantial after corrosion of said metallic film, and

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amended*
[thereby removing chlorine, bromine, or a compound thereof which are components of the gaseous etchant that remains on a surface of the metallic film exposed as a result of said removing of the mask, said] wherein removing of the residual gaseous etchant components [including] includes using the plasma to force [the] said gaseous etchant [compounds] components to be released from said metallic film and said [the] substrate.

Kindly cancel claims 20-22 without prejudice to the filing of one or more division applications directed to the subject matter thereof.

REMARKS

Reconsideration of the patentability of the claims of the above identified patent application is solicited in view of the above amendments and the following comments.

The examiner's comments concerning the allegation that the Japanese foreign document is missing from this file is acknowledged. Reference is made to the certified translation of this document which was filed with the amendment dated December 27, 1993. In order to expedite the prosecution of this application, enclosed is a copy of that submission. Reference is also made to the copy of the Japanese language PCT priority document which was filed along with this application. With the filing of these two

documents, it is believed that all of the necessary papers have been filed for according applicants their priority dated of June 27, 1990. Any publications dated after this date are not prior art insofar as this application is concerned.

Claims 20-22, which have been the subject of a restriction requirement, have been canceled. The fact that the examiner has both withdrawn them from further consideration and rejected them as well is not understood. In order to expedite the prosecution of this application, the rejection of the patentability of claims 20-22 will not be further discussed, since these claims have been canceled as being directed to a non-elected invention. The provisional election to continue the prosecution of the subject matter of the process claims of this application, that is the subject matter of present claims 1-19, is hereby confirmed.

The allowance of claims 7-19 is acknowledged.

This invention is directed to the process of etching a metallic film through a resist mask using a halogenated etching composition. It is more especially concerned with, in a second step, a novel means of removing the etching mask by ashing such while at the same time also removing any residual halogenated components which remain firmly adhered to the metallic film which has been etched or to the substrate which has been exposed by the etching operations. The critical activity of the process of the instant invention is to eliminate, or at least reduce, the residual halogenated etchant components to a level which is so low that after corrosion of the metallic film is no longer a substantial

problem. It has been found, according to this invention, that exposing the etched metallic film and remaining mask to a plasma of water vapor and oxygen gas will effectively ash the remaining mask and, at the same time, force the residual halogenated etchant components off the metallic film and the substrate and remove them. It has been found that ashing the mask in this manner takes the concentration of the remainder of the residual halogenated etchant components down to a level which is so low that after corrosion of the remaining metallic wire is no longer a significant problem in these semiconductor integrated circuits.

In the outstanding action, the examiner has continued to reject the patentability of the claims directed to this two step process, that is the subject matter of claims 1-6, as being directed to subject matter which is obvious from a consideration of the disclosures of the cited Colombo et al. publication in combination with the disclosures of the cited Shinagawa et al. reference and the cited Fujimura reference. The position expressed by the examiner is that the Colombo et al. publication shows using a chlorine containing etchant to etch an aluminum layer on a semiconductor located beneath a patterned resist. The examiner alleges that this Colombo et al. reference then shows passing the etched composite into a post etch treatment chamber where the resist layer is removed using an O₂ ambient plasma.

Actually, what the Colombo et al. reference shows is using one of four (4) post etch treatments for the removal of the patterned resist: in situ photoresist stripping; fluorine

containing plasma treatment; rinsing in water; and heating on a hot plate. This Colombo et al. publication cites the Yoshida et al. publication (reference 9) as representative of the state of the art. This cited Yoshida et al. publication discloses that the threshold level of chlorine which is allowable on the etched composite article in order to prevent the after corrosion of the aluminum wiring is 300 ppb. As will be apparent from a consideration of the disclosure of the Colombo et al. reference, Figure 11 thereof, the after treatments disclosed therein does not bring the level of residual halogen on the aluminum sidewalls down enough avoid after corrosion of the aluminum wire.

Thus, it should be clear that the in situ photoresist stripping, by post etch treatment with plasma containing oxygen as mentioned by the examiner, leaves a chlorine residue which is high enough to permit after corrosion of the aluminum wires. The only post etch plasma treatment described by the Colombo et al. article which yields a product with a low enough chlorine content uses a fluorine containing plasma. This is not a resist ashing plasma. In the instant invention, the removal of the residual halogen components from active association with the etched metal layer is accomplished as part and parcel of the resist ashing technique by using an ashing plasma which is a combination of oxygen and water vapor. The examiner has gratuitously added the allegation that the resist stripping plasma contains ashing oxygen. There is no support for this allegation within the four corners of the Colombo et al. reference. If the examiner knows of some

specific disclosure in this reference which supports this allegation, it is urged that he advise applicants of the specific citation thereof so that this position can be evaluated and countered. Simply referring to pages 95-99 is much too general to enable applicants to see exactly what basis exists for the examiner's allegation.

At most, the Colombo et al. publication calls for ashing with an oxygen plasma and a different neutralization of the residual chlorine. Nothing in this reference suggests that the resist can be ashed and the halogen values can be removed in a single step if the ashing plasma contains both oxygen and water vapor. That is what is being claimed here and that is nowhere shown or even alluded to by the reference.

In an effort to make up for the significant deficiency in the disclosure of the Colombo et al. publication insofar as the composition of the resist removing plasma is concerned, the examiner has cited the Shinagawa and the Fujimura references. Each of these references is concerned with means for improving the ashing rate and for reducing the radiation damage with respect to resist etched metal layers. Neither reference is concerned with reducing or eliminating the after corrosion of the aluminum wires by removing the halogenated residues of the etchant. Neither show anything which would enable a person of ordinary skill in the art to change the content of an ashing plasma in order for it to be able to both ash the resist and cause the removal of residual halogenated species. While it may be true that the

secondary references teach using a metastable plasma made up of water and oxygen, there is no disclosure in any of these references which would suggest that such a plasma might have anything to do with the removal of residual halogenated species from adverse association with the aluminum wire. Therefore, there is no impetus within the four corners of the three references being relied on by the examiner to combine the teachings of all of the references.

This is a classic case of applying hindsight obviousness. There is nothing in the references which would suggest that the problem being attacked by applicants in the instant invention even exists. Certainly, there is nothing in the references which suggests any information which would suggest a solution to the problem elucidated by applicants. What we have here is a classic case of the examiner looking at the elucidation of a problem and the recommendation of a solution to that problem, both of which are described in this specification, followed by a search through the prior art to find comparable processing steps regardless of the fact that the prior art does not apply them to the instant problems.

The use of the critical oxygen/water vapor plasma required by the instant claimed process enables both an ashing of the resist and a decrease in the residual halogen level to a low enough level that post corrosion of the aluminum wire is no longer a significant problem. The level to which the instant ashing plasma can reduce the residual halogen is much lower than is possible with a fluorine containing plasma as described in the

Colombo et al. publication. In this regard, reference is made to the data in figure 9 and the table on page 24 of this specification. In these data, the ashing and halogen reducing effect of an oxygen/water vapor plasma has been compared to the effect of an oxygen/carbon tetrafluoride plasma. It will be clear from these data, for chlorine removal, the oxygen/water vapor plasma is significantly better. There is nothing in the prior art which would have suggested this to a person of ordinary skill in this art. Not only is the plasma of this invention better in terms of reduction of chlorine, but it is a better ashing plasma as well. It will therefore be clear that the specific subject matter of the claims of this application is inventive over the disclosures of the prior art references which have been sought to be applied against the patentability of the instant claims.

In the outstanding action, the examiner has sought to reject the patentability of claims 1-6 over the combination of the Shinagawa et al. and the Tateiwa et al. references. The position espoused by the examiner is a mere repeat of the position he advanced in the last office action. Reference is made to the discussion in the last response which effectively shows why this combination of references is not antithetical to the patentability of claims 1-6. The Tatoo et al. reference discloses etching masked aluminum in a first chamber followed by resist etching with an oxygen plasma in a second chamber. The ashed wafer is then cleaned with a freon plasma in a third chamber and an insulation layer is disposed over the aluminum wires in a fourth chamber. After the

aluminum has been subjected to etching in the process described by the reference, it is not exposed to the atmosphere but is kept in a vacuum while the resist is removed and the insulating layer is deposited. Therefore, because the insulating layer is disposed over the etched aluminum, even if there is any residual chlorine on the side walls of the wires, it will not cause corrosion of the wires because it has been sealed against contact with the atmosphere.

The Tatoo et al. reference is wholly different from the process described and claimed herein. In the instant process, the halogenated residues are removed so that after corrosion will not occur. In the reference, it is not necessary to so carefully and completely remove the residual halogen because the wires are sealed against adverse reaction of the residual halogen with the atmosphere. Given the emphasis in the Tatoo et al. reference on maintaining the etched wafer in a vacuum and sealing it against intrusion of the atmosphere and reaction of the intruding atmosphere with residual halogen values to the detriment of the aluminum wire, there is no reason why a person of ordinary skill in the art would seek to change the resist ashing plasma to enhance the removal of further quantities of halogen residue. Thus, there is no reason for a person of ordinary skill in the art to look to the Shinagawa et al. reference or to use the oxygen/water vapor plasma of this reference except from a consideration of the instant specification.

It is therefore clear that the references which the

examiner have sought to combine are only associated with each other through the teachings of the instant specification. That is not permitted. That is hindsight obviousness which is not a valid reason for denying the patentability of the instant claims. It is therefore urged that the examiner reconsider his position and find the subject matter of claims 1-6 to be allowable.

If for any reason, the Examiner feels the application is not now in condition for allowance, it is respectfully requested that the Examiner contact, by telephone, the applicants' undersigned attorney at the indicated telephone number to arrange for an interview to expedite the disposition of this application.

In the event this paper is not timely filed, applicants hereby petition for an appropriate extension of time. The fee for this extension may be charged to our Deposit Account No. 14-1060, along with any other additional fees which may be required with respect to this paper.

Respectfully submitted,

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